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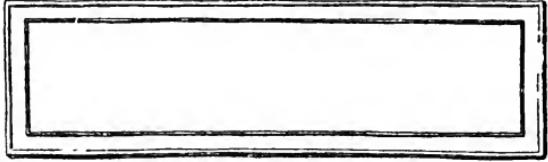
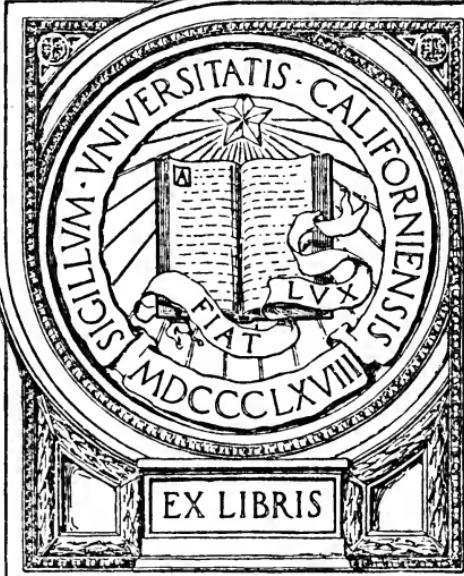


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IN MEMORIAM
FLORIAN CAJORI



To
AN ESSAY

ON

THE MEANS AND IMPORTANCE

OF

INTRODUCING THE NATURAL SCIENCES

INTO

THE FAMILY LIBRARY,

AND

DIFFUSING THE ELEMENTS OF GEOMETRY

INTO

THE PLAN OF THE POPULAR EDUCATION:

By D. McCURDY,

LATE A CLERK IN THE U. S. PENSION OFFICE.

SECOND EDITION, IMPROVED.

WASHINGTON:
BLAIR AND RIVES, PRINTERS.
1842.

CAJORI

Entered, according to act of Congress, in the Clerk's office of the District of Columbia, by **DENNIS McCURDY.**

NOTE.—An error in the orthography of this author's name was unintentionally admitted into the former edition of this Essay. The remarks made in connection with that error were intended for another occasion.

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1842

RECOMMENDATIONS.

The writer of the following discursive remarks served the republic during twenty-two years, *die et nocte*, as a teacher, in word and sign; commissioned and caressed by the people long before the strength of the young men had gone forth from the halls of the muses to disseminate literature and science in the land. Then, in 1834, after a suspension of two years or more, occasioned by disease, the effect of his application, he was employed as a clerk in the service of the government; and, in 1840, notified, with others, that from the 28th of February, 1841, his service should not be required. The last ten years have presented to his view, unsought, shades of human character deeper than those which he had been accustomed to contemplate; therefore, with incredible pleasure, he returns to the pursuits of Science, because he feels within himself the more cordial palpability of the benign radiance beaming from the beauty of her truths.

From many flattering testimonials furnished to him by citizens of this District, in order to favor his application for a school in the city of Baltimore, he thinks it proper to select for publication here the letter received from the office where he had the honor to serve; *for the public service is honorable in itself; but the manner of obtaining a place may be antithetical, and the servid ambition, incapacity, and catastrophe of Phaeton are recorded for our instruction.*

" WASHINGTON, July 30, 1841.

" We hereby certify that Mr. DENNIS McCURDY has been a clerk in the Pension Office for several years, and is now dropped in consequence of the decrease of the business. During his continuance in office, we have necessarily acquired a knowledge of his attainments; and do most earnestly and unhesitatingly recommend him to the Commissioners of the Public Schools in Baltimore, as possessing high and eminent qualifications as an instructor.

" GEO. W. CRUMP, *Chief Clerk.*

" JOHN D. WILSON, *Clerk.*

" HENRY H. SYLVESTER, *Clerk.*

" WM. S. ALLISON, *Clerk.*

" FRENCH S. EVANS, *Clerk.*

" DANIEL BROWN, *Clerk.*

" JAMES L. EDWARDS,

" *Commissioner of Pensions.*

The appointment in Baltimore was made in favor of a worthy gentleman, who had the greatest minority of votes at a preceding election for teacher. And, on application to be reinstated as a clerk, the President of the United States made the following endorsement of the papers submitted to him on our behalf:

dured their scorn, until by pertinacity he drew the current of public opinion into his ship's path over the previously unexplored deep. Upon men without fortune has always devolved the labor of instructing the world.

Such is the example which we propose to ourselves in urging the improvement of common school education, by the infusion of the elements of geometry. For this purpose, a plan of a Manual and Chart is proposed: a description of which may be seen in a subsequent part of this Essay. But, in order to place the means of acquiring the knowledge of science in the way of adults of both sexes, we here present a prospectus of a Magazine, which may be imitated by men of science in all practicable places. A periodical publication, commencing with the elements of geometry and arithmetic, and containing a well-arranged and complete course of mathematics, would be read, in many instances, by persons who could never be persuaded to undertake the subject by means of the books used in schools; especially if the illustrations should be so simplified as to supply the want of living teachers. Such reading, exclusive of the practical use of the sciences, would contribute to neutralize the deleterious effects of works of fiction, ultra politics, and all that exuberance of fanciful matter by which the morals of the age are relaxed, and the line traversed in every direction, which distinguishes right from wrong. The reports of the many violations of law and order would not be read for amusement, which is a certain patronage of the wrong-doer; the brightest parts would not be employed in depicting the vices and follies of men with a playful coloring of their enormity, from which the fascinated reader glides, among the puppets of the author, into those errors which he finds so elegantly described. The rule of right, upon which the eye of the freeman should ever be fixed, is not laid down in such productions. The false impression is not effaced from the reader's mind, that he is not accountable to God or his country until after he has entered his or her service by special agreement, and signed a pledge, or made profession to that effect. If the author is friendly to religion, he must disguise that. To acknowledge the claim of the Redeemer to the love of our race, is an insuperable barrier to that friendship. His regard for good morals also wants the rule—"To love one's neighbor as himself." Hence such writings do not, in any instance, reprove the reader for faults, nor afford any light for the correction of errors; which, after all, are mere negative utilities. And thus failing in the first part of the rule of improvement—

"Cease to do evil," they can have no pretensions whatever to the second part—"Learn to do well." Having, therefore, neither positive nor negative goodness, the alternative is evil; and, under these views, we cannot be of the number of those who would regret the loss of reputation, as such, to writers of this class, by a voyage from Europe ; because, in our humble opinion, that loss would rather be the recovery of sound discretion to a portion of the people, who had been, to some extent, deluded by the misapplication of great talents—a reduction of over-rated worth to its par value.

There is also another object to be achieved by the diffusion of the exact sciences, (if our people *will be gratified* while the Genius of our institutions weeps, and Modesty shrinks from the scene,) namely : to make the amateurs of indecent exhibitions intimate with the properties of the spiral curve ; that they may, at least, be able to criticise, with fastidious accuracy, the circumgyrations of all young dancers, patented at the courts of dukes and princes, as one of the means of governing their disfranchised *canaille*, whose return to sound discretion these magnates might have some cause to dread ; but who are entirely useless to our people in the administration of their affairs, either private or public. Useless, indeed, and inefficient for any purpose of good, but greatly prolific as the seed of evil ; because the artist, corrupt at heart, and ready to sell his country for sordid gain, exhibits for sale multiplied copies of such indelicate exposures ; and, in the interior of his impure shop, finishes the work of shame undisguised, to which he will invite the ripening debauchee, disgracing humanity, and breaking down the last impediment which obstructs the decline of virtue. Where, do you inquire, are the seats of such abominations ? Tamper with the crime in your theatres, and you will find the copies every where in the streets of your cities. Their favorite haunts will be near the legislative halls, dishonoring the precincts of the sacred fanes of human liberty, without the remedy of law, or a vindicator of the public sanctity. For how will your courts be able to convict or punish in the copy that which you have sanctioned and applauded in the original ? Citizens ! will you make the fine arts the medium of corrupting your morals ? Will you abdicate your rational forms of government, and be led by low sensations unbecoming the supreme dignity of the inheritance of your philosophic and Christian fathers ? Will you borrow your taste, as a people, from the kennels of paganism, perpetuated as it is in the unamended condition of a large majority of the populace of the old world ?

THE WASHINGTON MAGAZINE,
AND
JUNIOR CITIZENS' GUIDE TO SCIENCE,
BY D. McCURDY & CO.,

Will be issued monthly, at \$5 per annum, payable in advance, making an annual volume of nearly 600 octavo pages, with a plate of the appropriate diagrams to accompany each number.

It will contain a regular course of Mathematics, commencing with the Elements of Geometry and Arithmetic, in separate departments, and followed by Plane Trigonometry and Algebra, the art of constructing Logarithms, Surveying and practical Navigation, Geometry of Solids and Mensuration, Spherical Trigonometry, Conic Sections, and Astronomy, Carpentry, the Mechanics' Price Book, and Plans of Modern Buildings, Architecture, Civil Engineering, Mechanical Philosophy, &c., &c. It may be remarked that several of these and other branches differ only in name and application; that the general principles are common to many of them, and that the labor of acquiring the knowledge of the course is less than may be generally supposed: the principal hinderance consists in the impatient haste to pass over the first principles with the absurd question, "What use is there in that?"

The most approved authorities will be consulted, and the named Editor's long experience in teaching will be put in requisition for the benefit of those citizens who have to contend with the crude materials of Nature in organizing the habitable world. It is not intended to pass with a light saltation from one branch of the tree of natural knowledge to another, but to investigate the permeant elements in their course through the trunk, branches, flowers, and fruit; and to exhibit in the foreground whatever tends more immediately to the increase of human skill and power. Each particular branch will be based upon a sufficient number of theorems duly demonstrated, and illustrated by the necessary problems to meet the several cases which those theorems may embrace; but where different branches rest upon the same theorems, these latter will not be repeated.

In order to consociate amusement with instruction, the leading principles and rules of grammar, rhetoric, and logic will be inserted; and a chapter on the art and forms of keeping accounts; also a succinct historical account of the progressive improvements in the sciences, and a brief biography of eminent mathematicians, will be introduced at proper intervals in the work; and, that all classes of readers may be gratified, popular descriptions will be given of the natural and other curiosities contained in the National Gallery; also a regular account of the most important transactions of the National Institution, recently established in the city of Washington.

The Washington Magazine will be a family instructor of the cheapest kind; and a useful companion for the retirement of young men preparing themselves for high distinction in the national mart. Therefore, to extend the advantages of science, the remittance of \$20 from any college, academy, village, military or fire company, community or association, in the same letter, will be received in full for five copies of the Magazine; and in the same ratio for a greater number. The postmaster certifying the enclosure will make us responsible. The postage must be paid, or the letter franked.

Remittances may be made, in good money, to D. Clagett, Esq., merchant, Washington, D. C.; Benjamin Hallowell, Esq., Alexandria, D. C.; or Alexander Yearley, Esq., Baltimore, Maryland.

AN ESSAY.

The desire to diffuse, or rather to accumulate, knowledge, has recently received a simultaneous impulse from many points ; and the best talents in the world are concentrating their thoughts on the metropolis of this Union, to render it the Emporium of Science. Here the lines converge ; the march is onward, and no power at this time can retard its speed. The wisdom of men will consist in regulating and directing the momentum to the safest and happiest results, in promoting the contentment and industry of the people, and in preserving the due equilibrium of power by equal education, so as to ensure the faithful execution of the laws. We shall just notice a few of the most prominent indications of the desire referred to above, in order to show, in the outset, the increasing importance of diffusing the elements of science more equally among the people.

Indications of the desire to diffuse knowledge :

1. *In the action of Congress with regard to the bequest of Mr. Smithson.*
2. *In the establishment of the National Institution at Washington.*
3. *In the action of the friends of popular education in some of the States, resulting from the disclosures made in the last census.*
1. The Congress of the United States have assumed a trust, in the case of the Smithsonian bequest, under which they are pledged to establish, in the city of Washington, an institution for the diffusion of knowledge among men. To this undertaking, divested of any evil tendency, we wish

all possible celerity and success. It may be rendered useful; but, like the Grecian gift, it may introduce treason into the citadel of our liberties, by teaching us to love gifts, to depend upon contingencies, and be the less blessed of the two cases—namely, that of the receiver and that of the giver. Our own resources properly employed are sufficient for our wants. Giving to this testator's views the best construction, the bequest is a high compliment to our institutions, and to us a *memento* to persevere in that moderation which is the true characteristic of a people who are willing to do right—who require only the *light*, not the *compulsive power* of the law. In this view of the case, the trust, it must be admitted, is worthy of a free people, and their representatives are in every respect adequate to its execution. From the assumption of this trust, however, as well as from the annual appropriations for the support of their military academy, and the many excellent documents which are sent out from the halls of legislation at public expense, it is plain that Congress do not mean to admit any constitutional or other restriction of their power to diffuse knowledge. This is a gratifying disposition in the Legislature, to which we may hereafter advert in the course of these remarks.

But with respect to the species of knowledge to be diffused under the trust, there are various opinions. It is contended, in this case, that no kind of knowledge is proper which our citizens owe to themselves or their children; for this we should furnish at our own expense. This view, it will be perceived, excludes every branch of useful knowledge; because all such we owe to ourselves and our children, and more as a *reigning* people than we should as a *subject* people. Besides, we owe to the world as much as any other member of the family of nations, under the great Father of the universe. Is not our portion of the common inheritance equal to that of any other, nay, better than others? Has he not assigned to us from his table a Benjamin's mess?

Shall we then insult the Fountain of Light by admitting only a few rays, just sufficient to cause obliquity of vision, and qualify us to take delight in short-lived and local scenes? The people owe it to themselves to repel all suggestions to restrict or circumscribe their pursuit of knowledge; and every man should extend his sphere as far as may comport with the means and time he can honestly devote to its acquisition. Knowledge is the true lever of equality which can elevate the ponderous mass, and as such we are anxious to recommend it to all. We also believe that Congress may constitutionally erect an observatory at the nation's expense, and found a national institution embracing the ample range of the sciences and arts; that they ought to do so forthwith; and that the honor and dignity of the republic are compromised in the delay.

2. Another indication of the desire to diffuse knowledge is clearly developed in the establishment of an association at the city of Washington, in May, 1840, under the denomination of the National Institution. The object of this institution is to promote science and the useful arts. The number of its members already exceeds six hundred, and the increase is constant. The initiation fee is five dollars, and the annual contribution is the same amount. Its members are resident, corresponding, and a few honorary. The President of the United States is called the patron of the institution; it has a president, the Hon. Joel R. Poinsett; vice president, Peter Force, Esq.; twelve directors, of which six are elected by the institution, and the other six are the members of the cabinet at Washington; namely, the four Secretaries, the Postmaster General, and the Attorney General. The directors on the part of the institution, at present, are the Hon. Levi Woodbury and Hon. William C. Preston, Senators; Col. J. J. Abert, chief of the topographical engineer bureau; Col. Joseph Totten, chief of the engineer bureau; A. O. Dayton, Fourth Auditor of the Treasury; and Com. L. Warrington, one of the Commissioners of the

Navy Board. Francis Markoe, jr., Esq., is the corresponding secretary; G. R. Barry, Esq., recording secretary; and Dr. H. King is the curator of the institution. The subjects of research are divided into eight classes, namely, astronomy, geography, and natural philosophy; natural history; geology and mineralogy; chemistry; the application of science to the useful arts; agriculture; American history and antiquities; literature and the fine arts. Besides the numerous specimens of geology, mineralogy, and other objects of natural history collected by the members, the association has in charge the immense variety of curiosities sent home by the exploring expedition. The correspondence of this institution already extends to all parts of the world, and its present condition is highly pleasing and prosperous. Its depository is the new national gallery—one of the rarest specimens of architecture, and said to be the most spacious room in the United States. We propose to give, in the future numbers of our contemplated magazine, a fuller account of the transactions of this institution, and a classified description of the astonishing collection of the productions of nature and art, civilized and savage, placed in charge of the curator of the institution, Dr. King.

3. The last indication of the growing desire to diffuse knowledge which we shall here notice, is the action of the friends of science in the States, impelled by the disclosure resulting from the statistics collected in the taking of the last census. It appears that many of the people are destitute of all literary knowledge, and large masses of the community receive but a very limited education. This action will be the more effectual, because it carries the remedy to the seat of the disease. When the people undertake to do their own work, it will be done. The lark, in the fable, thought it unnecessary to remove her young from the wheat-field while the farmer depended on neighbors or friends for his reaping; but when he concluded to begin by himself *on the morrow*, she exhorted her little brood to provide for

their future safety. There will be no more delay in this diffusion of knowledge, since the proper agents are to be employed. We are, however, constrained to express the hope, that the basis of whatever system they may adopt will embrace the elements of geometry, as being necessary for the support of any superstructure which can avail in erecting the minds of the people.

Astronomy, which leads the whole train of the sciences, is dependent on the elements of geometry.—The National Institution, as appears from the preceding arrangement, has very properly placed astronomy at the head of its list of the natural sciences. This is the study which first inspired man with the spirit of inquiry, and for the sake of which the subordinate sciences have been intensely prosecuted. *Dedit homini sublime os.* In its modern improvements, the application of its principles descends even to regulate the weights and measures in the hands of the merchant. It sweeps the cerulean expanse with the telescope, watches the motions of the heavenly bodies, and collects its *data* from a thousand stations at a thousand dates; adding to the number of celestial discoveries such revolutions and phases as the planets and satellites exhibit from any peculiarity of the observer's position with regard to the ecliptic, or highway of the distant worlds. "And never," says the Hon. Joel R. Poinsett, late Secretary of War, and senior director of the National Institution, in his excellent discourse delivered at its first anniversary, "never has been commenced a monument to the glory of science and human intellect more sublime than that of which astronomy is now laying the foundation." "Shall we not add," continues Mr. P., "one stone to the structure? Will we expose ourselves to be denied our just title of a moral, intelligent, and enlightened people, by refusing to inscribe the United States of America among the names of the civilized nations of the earth, which will be found engraved upon the columns of this magnificent temple? Are we not a navigating and

commercial people? Does not our flag float on every sea, and visit every accessible region of the world? And shall we not have our national observatory, our astronomical archives, and our celestial ephemeris [day-book]? Shall we any longer leave our navigators exposed to the disgrace of acknowledging that, without the astronomical ephemerides published in Europe, they could not with safety navigate distant seas? I hope not." And so, to echo the pious aspiration, we all hope. Nevertheless, whatever praise may be due to the noble science of astronomy, no practical utility can accrue to the community from it, without a previous knowledge of geometry, upon the principles of which astronomy must be superinduced. It is, therefore, our intention, in the humble office of pioneer, to co-operate with the magnanimous designs of this excellent institution, by disseminating the elements of science more generally among the people; without which they must come unprepared, though invited, to the intellectual feast.

The same elegant writer and true patriot, in speaking of the science of technology, or the union of scientific knowledge with mechanical skill, instances the case of James Watt, LL.D., who invented the steam-engine, the most perfect of human devices, "a present," so called, "from science to the arts." And the case of Peter Dolland, who accomplished through this Union, what even Newton had given up as unattainable. Mr. P. here alludes to Dolland's equatorial instrument for correcting the errors of refraction in altitude, of which the inventor gave to the Royal Society some account in 1779. The discourse here alluded to furnishes an outline of what a National Institution ought to be: it has been distributed gratuitously, and may be had, we believe, at the Patent Office. No intelligent citizen should omit the perusal of this valuable pamphlet, or the subscription of his name to the National Institution therein defined and recommended.

A Magazine of the natural sciences, for the family library,

should commence with the elements of arithmetic and geometry.—We have thus briefly adverted, *ad res gestas*, to the things done, or contemplated to be done, at Washington, and in some of the States, for the diffusion of knowledge among men. We desire to point the telescope of consideration to the hill of science in the far, elevated, serene distance; that the junior multitude, whom we would rouse to application, may have some idea at least of the direction in which we propose to lead them, by means of the magazine which, with the aid of the friends of science, we propose to publish. But as in the outset of every journey some preparation is demanded, so likewise shall we be required to make provision for the way. It is, however, peculiar to this line of march, that, in collecting the materials, our progress will be facilitated; and the elements which we collect will be no impediment to the celerity of our advancement: on the contrary, the more we collect, the more rapidly shall we approach the object at which we aim. Let these remarks be now applied to the acquisition of the elements of geometry and arithmetic, without the aid of which no progress can be made in mathematical knowledge; and let it be understood that under these two heads are all the elements of the exact sciences contained.

Geometry and arithmetic should have priority of algebra.—Mathematical reasoning is conducted according to two methods,—one is called the method of *analysis*, or *resolution*; the other, the method of *synthesis*, or *composition*. Algebra adopts the former of these; separating the known from the unknown parts of a general proposition; representing number and magnitude by symbols, and descending by a succession of equivalent propositions from the most complex to the most simple form. Geometry adopts the *synthetic* method, which begins at the simplest elements, and proceeds to the most complex combinations: moreover it seizes upon the matter and forms of extension in their natural state, or represents them exactly in miniature, making the relations

subsisting between lines and angles, superficies and solids, familiar to the senses, which the algebraic symbols cannot do, from their position and other obvious properties and accidents. In like manner is algebra, with all its facilities of substitution, transposition, and elimination, dependent in its application on a previous knowledge of arithmetic: for it must employ the algorithm of numbers; and since every number is a term of some series, the relations of the given numbers must be understood from the law of the series to which they belong, and from their position in that series, before any advantage can be gained, either in the demonstration of a theorem, or the solution of a problem, by means of symbolical representations.

For these reasons, we shall set forth, in the leading numbers of our magazine, the elements of geometry and arithmetic; and shall not attempt to generalize or concentrate propositions too hastily, lest we might defeat our most cherished hope, viz: that of enlisting in the cause of science the greatest possible number. Our object is to diffuse this knowledge where it is most wanted; and there is no greater obstacle to this diffusion than the formulæ of algebra applied to principles not clearly understood. This doctrine is urged by Sir Isaac Newton, and his great preceptor, the learned Doctor Barrow, who deprecated in this pursuit nothing else so much as the too early application of the analytic method, which is chiefly introduced with the use of algebra. There is in algebra no elementary principle: why, then, should it precede those studies upon the principles of which it seeks to be engrafted? Can the proportions of numbers or the relations of magnitudes be at all understood, when expressed only by the letters of the alphabet, which have not now, as anciently, a definite numerical value assigned to them? The supposition is preposterous. In short, a contracted and obscure view of the uses of mathematical knowledge has been superinduced by the early application of literal arithmetic and the neglect of geometry: hence this

latter subject is scarcely at all estimated in the plan of the popular education ; the seeds of knowledge are withheld from the youthful and vigorous soil, by the malign influence of inveterate habit, which clings to restrictive and discriminating rules in the diffusion of knowledge, even in cases where the means are freely and amply provided.

It is not our intention, however, to decry algebra, or to dispense with the facilities which it affords as the great auxiliary of science. On the contrary, we shall, in the prosecution of this work, pursuing our research into the latitudes and longitudes, the depths and sublimities of Nature's laws, and their best imitation in the works of art, avail ourselves of all the aids derivable from *method*, whether of composition or resolution ; we shall not omit nor overlook the interests of the practical mechanic, or the man of science; but shall introduce, successively, with proper regard to the natural order and mutual dependence of the sciences, those branches or parts of the mathematics which are most promotive of public utility.

The Magazine should explain the terms which involve principles in arithmetic as well as in geometry.—In the arithmetical department, it will be deemed expedient to define certain words, for the sake of the principles with which they are connected, and to familiarize our junior readers with the particular views under which these elements are to be presented. A variety of facts relative to the doctrines of numbers will be collected under this head, which may occasion some appearance of delay ; but, as in the clearing of a forest for cultivation, many difficulties will be thus removed, and time and labor saved in the general result. In the list of definitions the words will be placed in alphabetical order, for the convenience of reference ; and it may be necessary to refer to several words, in order to understand the principle to be explained, as the words give a mutual explication of each other, and one illustration sheds its light upon another.

An explanation of the true principles of induction, as applicable to arithmetic.—The organization of units into series in the formation of numbers, as the fundamental law, has not been regarded by writers on arithmetic in the full extent of its importance; and the effects of secondary causes have been substituted in its stead. Hence the light has fallen obliquely, and by reflection, upon many useful principles, and errors have been interwoven with the truths of science in the protracted shades.

Arithmetic is the science of the numerical series. This is its true definition; and it will be found useful to consider the series of cardinal, ordinal, multiplicative, and distributive numbers, as in grammar. We shall here notice, however, only the series of cardinal numbers, or the numerators of things. In whatever way a relation may occur between *required* and *given* numbers, that relation must be investigated along the line of some series. And it may be remarked that all series consist of consecutive sums, differences, products, or quotients; since these include all the operations of numbers. The series of numbers may all be ranged into two principal divisions: FIRST, the *regular*, which have their terms increased or decreased by a constant equal quantity; and, SECOND, the *irregular*, whose terms are in like manner affected by a variable quantity. Each of these divisions may also be subdivided into *classes*: and of the regular division, the class of series which have their terms equi-different are called *arithmetical*; and the class whose terms are continued proportionals, are called *geometrical*. Again: of the irregular division are all additions and subtractions of simple numbers, where the result is pursued, as it were, by placing the given terms consecutively along the line of the natural series; also the series of triangular numbers, which, for several years, under the name of lotteries, has been the medium of the most frightful system of deception and furtive traffic, with the sanction of ignorant or interested rulers, and supported by the cloying cozenage

of a venal press. To digress a little into the history of this case, it may be remarked, as a very probable circumstance, that the much boasted plethora of a certain State treasury is occasioned by the revenue derived from the neighboring cities by the sale of lottery tickets; from which delusive and criminal traffic the unhappy adventurers can realize no other issue than a succession of disappointments.

But to return to our subject: To the irregular division belong all the series of squared, cubic, and pyramidal numbers; and those series whose terms consist of two or three unequal dimensions, as in the piling of balls, &c. In this division are also the series of powers and roots; but the logarithmic series of indices or exponents is arithmetical, and belongs to the regular division. Of each division and class there is also an infinite variety of series, and the natural series contains the terms of every other. The decimal terms 1, 10, 100, 1000, &c., or their multiples, as high as the ninth inclusive, in reversed order, constitute the organic law of the notation of numbers; and, lastly, every series has its own measuring unit, to which every unit of that series must be equal in dimensions and value.

In view of all which, it is obvious that the compilers of systems of arithmetic have not assumed the true principle of the science, either in their definitions, rules, or exemplifications; that they have marked out no certain path to its perfection; and, consequently, that the progress of their followers is caliginous and erratic. In this consequence, the editors who have professed to favor the inductive system are also involved, because they have given no evidence whatever that they have made the discovery of the general law *into which leads INDUCTION.*

The leading numbers of the Magazine should not contain abstruse questions.—This magazine will contain a complete course of mathematics, and be rendered subservient to the purposes of education in families; aiding adults in revising their former studies, which may have been passed over

too superficially ; and juniors, by a collocation of questions, under appropriate heads, in mercantile and mechanical arithmetic, adapted to the most ordinary capacities, and referred to the proper series in every instance ; so that, among the earliest lessons, the laws of the several classes of series which form the basis of all the modern improvements in the mathematics will be made familiar to the reader. The object of this publication will preclude, at the first, those abstruse investigations in which the sons of science delight to exhibit their skill ; and no question can be admitted into its pages in anticipation of the principles upon which such question is founded. We intend to instruct, not to puzzle our young readers. Our first numbers will be devoted to the *elements of science*, for the use of that large majority of citizens who want “the appliances and means” of improvement. It required strength to bend the bow of Ulysses, and detailed practice to perform the problem of the arrow and ten rings ; so skill in, and power over, the elements of science accumulate by continued acquisitions.

Geometry is at war with the lawless condition of mind and matter.—The elements of the exact sciences cannot be treated in a discursive or amusing manner ; on the contrary, the random of fancy is to be arrested, sophistical arguments are to be avoided, and the mental faculties required to submit to the impression of truth unmixed with error. Geometry deals in realities, rests on admitted principles ; and its process of investigation is the test of philosophical truth. But when these principles are duly cultivated, they afford the most ample means of rational amusement ; proving that reality is more astonishing than fiction, because the diversified operations of Nature are more in number, beauty, and splendor, than the wild imagery of the most fruitful fancy, and the discoveries of science excel all the painted scenery of poetry and romance. Therefore the votary of science is amply rewarded for the time and pains expended in acquiring the rudiments of this knowledge, which has to contend for its

very existence against the gayer *allurements* of the *spume*, and the unprincipled *drowsiness* of the *sediment* that mingle too freely with the better elements in the composition of the world.

The investigations of the sciences dependent on geometry are limited within the known parts of the creation. The line and plummet must never be out of use.—The sublimest effort of these studies is to trace upon the tablet of the human understanding a copy of the plan of the creation, the temple of the Deity ; and to demonstrate the action of its laws from the partial view of them attainable in this remote position in the solar system. They do not carry us out of the limits of God's works beyond the region of light—*extra flammantia mœnia mundi* ; nor place us anterior to the existence of time and the motion of bodies, when space alone existed : because, in the contemplation of *empty* space, there is no point with which to compare, no principle of action or motion, and consequently no notion of life and its concomitant enjoyments ; therefore, to date the principles of this knowledge anterior to the motion of bodies, except as existing in the wisdom of the Deity, is an absurd abstraction, anti-geometrical, a mere speculation of infidelity, which never stops at the proper point, and, from its morbid disaffection to the Supreme Ruler and his laws, runs into all those absurd extremes to which geometry accords the most consummate reprobation.

From the motions of the upper worlds the sciences descend to examine the contrivances of art, and to teach mankind, from the combination of a few simple principles discovered in matter, to exert incredible force and ingenuity in the production of the most useful ends. These subjects will claim our future attention ; and having access to the Library of Congress, the Patent Office, and other sources of information, it will be our aim to select such materials as shall be deemed most profitable to our readers, in accordance with our intended plan of conjoining theory with applica-

tion, and of ascending the hill of science, as the guide of a multitude of our junior cotemporaries, by easy, that is, by regularly graduated steps.

The popular education is defective with regard to means.—Means are wanted to supply the defect, as far as possible, in the popular education. There are, it is ascertained, about one hundred colleges in the United States; and in these a number of students somewhat short of ten thousand are receiving instruction. It may also be inferred, from the late census, that near three millions of persons are of the proper age for instruction in schools. Deducting the ten thousand students from three millions, there will remain two million nine hundred and ninety thousand. This immense majority derive no direct advantage from colleges, and very little indirectly; because graduates of this order generally have higher pretensions than that of the humble office of common-school teacher.

Let us inquire, next, whether the principal academies will make amends for the want of college assistance: of these there may be six hundred in all the States, giving instruction to sixty thousand pupils; which, deducted from the last remainder, will still leave two million nine hundred and thirty thousand, who either receive no instruction whatever, or so limited a share of it as to leave them unqualified for the duties of statesmen, legislators, judges, magistrates, clergymen, physicians, lawyers, military or naval officers, navigators, or even masters in any of the subordinate trades and professions. Yet, from this overwhelming majority of unqualified citizens, the several offices above mentioned must be supplied; or, at least, they are to be the judges who will determine as to the qualifications of those who are to fill them.

An uneducated population are the materials of a despotism.—Now, one of two destinies awaits our form of government: either it shall become a despotism, or one of progressive social improvement; dependent, in the latter case, on the gen-

eral and more equal diffusion of knowledge. The materials of a despotic government are the millions whose education is so far neglected as to eradicate their sense of equality, who, losing sight of the first general maxim in the Declaration of Independence, are ready to admit that they are a subordinate class, and who look to no alternative but a change of masters. The population here described, whose individual ambition can avail them nothing, have nevertheless a powerful collective ambition; though they are undisciplined in the laws, regard their operation as partial, and abhor their perplexity, yet they have patriotism, swell at the recital of their country's glory, and never forget the name of a successful warrior. They undervalue civil acquirements, the operations of which have no sensible effect; but they are all eye, all ear, all heart, to the tumult and ostentation of war. The consequences of their united action may be these,—that the chieftain who shall lead them out to repel their country's invaders may probably lead them in to remodel the government more agreeably to his will. The machine will be found too complex for the general and his followers, and they will reduce it to the simple form of a general order. The eye of such a populace rests upon the executive, not upon the laws.

Domestic education is the most available.—Such are the results which must necessarily arise from the neglect of the popular education; and these results, which every good citizen must earnestly deprecate, are not so remote in the long vista of ages as we may supinely think; the means of prevention cannot therefore be safely delayed. The means of discipline in useful knowledge, to meet the exigence of the case, must be sent home to the residence of every citizen, to the farm and shop, where labor and study may relieve each other, and the common mind be enlightened with science at the least expense either of the endearments which sweeten the springs of domestic felicity, or of the necessary labor of the people and their pecu-

niary means. They have neither means nor opportunities to acquire the proper culture at remote and higher institutions.

Equal means of education are necessary to preserve a free government, and avarice is its antagonist.—There are, as we have remarked, three millions of persons in the United States who should be receiving instruction sufficient to qualify them for any office in the people's gift. Seventy thousand of these derive the form of a liberal education from colleges and higher schools, and two million nine hundred and thirty thousand are comparatively neglected. But who will undertake to affirm that these, the latter class, are less endowed with natural intellect than the former?—or that, in their business through life, they less require the aids of literature and science? The defect of equal and general means for the education of a *free people*, is thus obvious to the least penetrating observer. And this defect tends to create different orders in the community; to be maintained for a time by art, but finally by an armed aristocracy, as in Mexico, against the common rights of the people, and the provisions of our excellent constitution. It is, however, contended that education makes men more vicious. That must be a bad education, for which we have no desire to provide; and we also admit that the disparity of a good education leaves a portion of the citizens unprotected. But the argument against education, whatever it is worth, is drawn from an equality of ignorance; and we aver that the equality of intelligence will ever have the same claim to innocence. Besides, intelligence is the characteristic of freedom, of which the United States furnishes conclusive proof. Education should be of that kind that resists the commonest and most pernicious vices. Now, avarice is the first vice of this and every other commercial people. The present generation are suffering the inevitable consequences of this passion, which is antagonist to a commonwealth, and which was unknown to the fathers of the

republic. The accumulation of great wealth is a very ambiguous test of virtue, and one with which the people are never so well satisfied as the security of the possessor might require. Hence, the throes of the country: hence the strong effort of our institutions to defecate the impure principles which have aimed at their subversion. Let go your ill-acquired gains, increase the amount of productive labor, and educate men to moderation, and all will be well. It is commonly charged upon the profligate and the idle, that though property were for once equally divided, another division, and another, would be necessary to preserve the equality. But this consequence is produced by the covetous man rather than the spendthrift. The latter relaxes his grasp upon his property, and the former snatches it out of his hand. One is generous and unsuspecting, the other is subtle and rapacious. One would permit a portion of the public property to be in common, the other appropriates to his own use every thing which he is able to seize. If all the wealth which can be acquired from the imbecility of others, or through the error of legislation, be justly yours, why not at once return to the old doctrine, that *might is right?*

Legislation requires intellectual discipline and experience of the relations of society.—We would, however, insist on the necessary qualification in our rulers: we say, they ought to be educated men. It is our intention to excite emulation, not envy. Let us examine society in its formation: it is the natural condition of man. The writers on international law, to form some basis for an argument, have supposed cases of solitude which have never existed. To talk of rights in the case of one who has abandoned all his rights, and can suffer no wrongs, unless those which he may inflict on himself in his gloomy forest cave, is one of the extravagancies of infidelity for which some of these popular writers are remarkable. Man came into society when he came into existence: all men are born equally helpless;

they have a right to life, for the same reason that society has a right to exist; and, for any thing that appears in evidence in the matter, one is as well entitled to liberty and the pursuit of happiness as another—*id est*, liberty to seek or pursue his happiness;—which happiness consists in the enjoyment of that temperature of mind that is effected by the unresisted action of the law of his being. The Creator has willed man's happiness, but the means are not acquiesced in: hence society requires to be connected and secured by sanitary regulations. The members of society are dependent on each other; the whole body is dependent on the Great Original Existence. The machine is a complicated one, and its laws must be in some measure understood by the man whom we could conscientiously recommend to one of its responsible offices. Therefore, we aver that legislators, judges, and executive officers should understand the structure of the body politic, and also the rights and moral obligations of the whole, as well as the several parts. In short, every human enactment ought to assume to be nothing more than a simple declaration of some inference deducible from that general rule, by the observance of which the happiness of the whole and of the parts is promoted.

For such reasons as these we would rather see men holding responsible offices who have undergone a course of mental discipline; but we wish all, or a sufficient majority, as many as possible, to be eligible; therefore we desire to let out the streams of science upon this national husbandry in every possible direction. The available *media* for the diffusion of knowledge, now in existence, are the colleges, academies, and common schools; of which the number of the latter bears to that of both the former about the same ratio as three hundred to one.

Concentration and diffusion of knowledge contrasted.—The concentration and the diffusion of knowledge may be contrasted. High and expensive institutions tend to the

former rather than the latter ; the seeds of knowledge, like those of plants, must be disseminated upon the broad basis, not grudgingly, but with a generous hand ; we may add, after the manner of Christianity. The same may be said of eminent works of science. To the Principia of Newton, perhaps, no well-adapted additions could be made ; but the general diffusion of this colossal knowledge requires means different from any that have been hitherto employed ; and so likewise of geometry and other natural sciences. Colleges and academies are too expensive to be placed at all points ; it follows, therefore, that the common schools of the country are the proper *media* for the diffusion of knowledge. But it may be said that these are already effecting the object contemplated in their establishment. This may indeed be true in numerous cases ; but the object so contemplated may not be commensurate with the increasing necessity of knowledge. We have known certain schools which have been supported liberally, at public expense, for a quarter of a century, in which the progress of science has been stopped at the point which they technically call the *rule of three*. This may have been the contemplated limit of the object for which such schools were established ; and the practice has corresponded to the design. But such restriction is evidently incompatible with the march of mind, as well as with the natural fecundity of the mental soil. Was this the proper method to neutralize the superior advantages of collegiate instruction, and equalize the acquirements of the citizens in knowledge and power ? Certainly not. The case alluded to may, perhaps, be of rare occurrence, representing common schools in their least efficient state.

The metaphorical tree of knowledge.—The *tree of knowledge* is a familiar figure of speech ; and the departments of science are so commonly denominated *branches*, that this term is scarcely regarded as a metaphor, but rather as a literal expression. It would, however, be no disadvantage to the cause if the figure were carried out more

extensively, so as to embrace the trunk, juices, and fruit; also the condition of the tree, whether as a stunted shrub or a stately fruit-bearer. This would afford a basis for a more vivid illustration of the minute origin, connexion, dependence, and progress of the elements ; showing, from the nature of the fruit, branches, &c., that the seed is of two kinds—number and extension ; that with number alone, only a stunted shrub is produced ; that although the larger and smaller branches of the stately tree partake of the properties of numbers, yet those of extension are so interwoven in the entire texture as to preclude access to the fruit by the skill and power of numbers alone ; that the season of planting and culture ought not to be neglected, and that the soil ought to be duly selected and prepared.

The elements of science are not acquired at the proper season, and therefore rarely ever. Their light is *hid as under a bushel* from the mass of the people ; or, to use a continental simile, the channel of their mighty river is closed by the sunken rafts of time-honored erudition, and the deep current passes off on the sinister hand, for the exclusive benefit of a very limited number. Even in the best institutions the quantity of this knowledge is abated, from the want of appropriate means of acquiring it in the preparatory schools.

School commissioners and trustees are bound to lay a proper foundation for public instruction.—To incorporate the elements of geometry with the popular education is an indispensable duty, binding upon those who are intrusted, by commission or otherwise, with the direction of this important branch of public affairs. Let your pupils read and become familiar with Euclid's propositions and diagrams at the proper age, before the opportunity is snatched away from them by procrastination. Consider the results in the cases of Newton and Bowditch, and a thousand others of merely accidental opportunities of reading works of science. The former of these great men was not intended for a liberal scholar : he was employed as a helper

on his mother's farm, when Euclid's Elements fell into his hands: he understood the propositions of that author by simply reading them; they presented to his capacious mind no difficulty; and from such powerful manifestation of intellect was drawn the motive for sending him to the university. He lived to express his regret that he had occupied so much time upon the theories of Des Cartes, and that he did not limit his investigations within the range of the principles of Euclid's Elements, as being the most direct way to his own discoveries. Doctor Nathaniel Bowditch, it is well known, collected the seeds of science, by which he has done honor to his country, and established for himself an imperishable name, from some volumes which he found in the ship-chandler's office where he was employed. Give to the rising generation *the means* of perusing the elements of geometry,—this is the defective point for which there is no equivalent study,—and the next age will be illustrious for its Newtons and Bowditches. Then will arise many ornaments of society in this department of knowledge. After the manner of Sir Charles Scarborough, they will be able to repeat, in order, all the propositions of Euclid, Archimedes, and other ancient authors; and, like Sir Isaac, comprehend them without the labor of much study. The eminent mathematician above mentioned was physician to Charles the Second, and his two successors, assistant and successor to Doctor Harvey, as lecturer on subjects of anatomy and surgery, and the first who judiciously applied mathematics to medical subjects.

A Chart and Manual of Geometry for the use of schools recommended.—In addition to the magazine herein proposed to be published, as one of the incipient means of diffusing the knowledge of the exact sciences more equally and generally among the people, we have devised a series of charts of the diagrams of geometry, and a manual of the definitions, postulates, axioms, and propositions of Euclid to accompany the charts. This, indeed, is but the seed of a glorious har-

vest of knowledge—worthy of being so esteemed, because of its general diffusion; and general, because of its congeniality to the operations of every well-regulated human mind. It is our earnest wish to make the impression of the forms of extension precede the work of analysis, and to furnish the corresponding propositions according to the ancient and approved order of the Greek geometer. Any deviation from this arrangement would only open the way for an endless train of pretended improvements, which would no more subserve the purpose of general diffusion than the present refinements of analysis are effecting.

A description of the Chart and Manual of Geometry, with the title of each, and the supposed terms of their publication.—The chart No. 1, of the series here alluded to, will contain the diagrams of the six books of Euclid; exhibiting nearly three hundred strong lined figures, on an area of twenty square feet of plate paper laid on cloth, with moulding and roller, bound and varnished in the manner of a map; or, as it will consist of four equal plates, if required, it may be so mounted as to fold in quadruple, without the wood, for the purpose of transportation. The manual No. 1 will contain the definitions, axioms, postulates, and propositions of the same books, wanting the demonstrations. The rules for constructing the figures will, however, be given; also the references to the elements preceding each, usually quoted as proofs.

1. The Chart of Geometry, No. 1, exhibiting the diagrams of the first six books of Euclid: to accompany the Manual of Geometry, No. 1, containing the propositions and other elements of the same books. Price, \$5 per copy.

2. The Manual of Geometry, No. 1, containing the definitions, postulates, axioms, and propositions of the first six books of Euclid: to accompany the Chart of Geometry, No. 1, exhibiting the diagrams of the same books. Price, not exceeding \$3 per dozen. But each copy of the chart will be entitled to one copy of the Manual without extra charge.

It will be recollected that, wherever geometry is taught, the figures are commonly drawn on a blackboard, and effaced with the occasion; losing thus the advantage derivable from subsequent reference. If this practice should still be continued in connexion with the chart, the latter will serve as a record of such transactions, and be a useful auxiliary in the college hall, as well as a pioneer in the preparatory school.

Geometry and arithmetic should be taught at the same time.—It is susceptible of the most satisfactory demonstration that arithmetic and geometry should be simultaneous studies; it is also well known that the want of a practicable plan, alone, has in many instances prevented this union. It is proper, however, to remark, that the former requires the aid of the latter, rather than the contrary. Geometry depends for the proof of its propositions upon its own elements; whereas arithmetic requires the extended dimensions of geometry to illustrate the principles of its operations: this will apply, however, to the case of rectilineal figures. In the theories respecting curves, the excellence of Newton's demonstrations consists in his superlucid application of the doctrine of infinite series, in which geometry requires the aid of numbers; in the mixed mathematics, they are professedly subservient to each other.

The entire labor of demonstration should not be at once imposed on the learner.—It is reduced to a maxim, that the classification of labor facilitates its performance. The plan here proposed is to omit the demonstrations, but not any of the elementary principles, in the commencement of this study. The first care of the learner should be to know each proposition in order; its data, or given parts; its *quæsita*, or requirements; to construct the corresponding diagram, or at least to trace it out with a pencil, or otherwise, by its points, lines, and angles; so that it may be clearly identified with the proposition, and the enunciation of the proposition readily given from an inspection of the diagram. These

preliminary exercises, which do not fall far short of the full amount of labor required in this study, may be performed in the family circle, in schools of any grade, by any person who can read, as well as by a learned geometer. Let no time be lost in committing to memory the definitions, axioms, and postulates, since the constant reference to them, at each proposition, will soon render them familiar; read them, and pass on to collect other facts.

Youth is the proper time for acquiring science, and forming an intelligent citizen.—In order to form the young mind to place within it the organizing principles of geometry, the burden of this study must be assumed in youth,—that season of life in which the memory is susceptible of defined impressions, and most willingly submits to the imposition of a task; and these elements must be thus acquired, or the demonstrations cannot be effected; he shall only make the discovery of his own impotency (for want of knowledge is want of power) who will undertake the latter without the necessary preparation. And unless a man possess the intuitive perception of the truths of science, or receive it by a course of instruction, a morbid ignorance and hesitating uncertainty will embarrass all his thoughts, or a precipitate, turgid, unwarranted assurance will mark his course through life; one unbalanced passion will control him; he cannot be an enlightened citizen of this republic; he will behold the improvements of art with a vacant stare, and be a helpless loiterer in the march of mind. The moral influence of the sciences is not duly appreciated in the affairs of this Government, dependent as it is on the popular will.

Geometry taken in the Euclidian order is not abstruse, and may be learned by any good reader.—If it should be objected that the study of geometry requires maturity of judgment and riper years, it may be answered that the mind, in this case, is required to create nothing; the statements and proofs are all furnished; and the principles, as

well as their application, are as simple and obvious as those of grammar or geography. This latter branch is, indeed, a dependent on geometry, deriving its forms and proportions from it, having been successfully and commonly taught in schools only a few years,—that is, since the atlas accompanied the book of descriptions. And as to grammar, it is comparatively abstruse and metaphysical; not a subject of form or extension, and therefore evading the action of the senses; yet it has been reduced to the capacity of juvenile learners, and made a common study in all the schools. Geometry, taken in the Euclidian order, is easy and natural; an isolated problem, depending on principles wholly unknown to the performer, (and this is what we propose to provide against,) presents an insurmountable barrier to the tallest intellect; like the elevating of a block of marble upon a lofty column, which cannot be effected without the intervention of the mechanic powers; so the difficulties of all such problems are removed by a previous acquaintance with the Elements of Euclid. With a due regard to the progressive abilities of the learner, it may be said that he is prepared to enter upon this study so soon as he can read sufficiently well to exercise his memory on the subject of his lecture.

Teachers may acquire this knowledge from the recitations of their pupils, without any previous study.—To teachers unacquainted with geometry, but who desire to extend their sphere of usefulness, the plan here proposed presents the most favorable opportunity of learning from the recitations of their pupils. The frequent rehearsal of the same task through successive classes, with the continual reference to the diagrams on the chart, and to the preceding proofs at each proposition in the Manual, cannot fail to give the impression of this knowledge in the shortest possible time. Many zealous and qualified laborers would thus enter the fields of science; the laws of Nature would be more fully explored, and made the subjects of general reflection and

models of action among men. Hence the most beneficial results would accrue to the community from the regulating influence of those perfect examples upon the ardent passions of the young : the moral as well as the intellectual condition of society would be improved, by diffusing the knowledge of Nature's laws, of whose operation geometry is not a system of symbolical representations, but rather a miniature likeness.

Colleges have a pecuniary interest in the promotion of this preparatory study.—Professors and teachers who have the charge of instructing young men in the mathematical department in colleges and academies are expected to sanction this plan, until a better can be provided, of inculcating an early acquaintance with geometry. Here the materials will be prepared to some distance in advance of the qualified demonstrator, who will doubtless find the business of *wrangle* not only facilitated, but greatly multiplied on his hands, by the immission of eager applicants from the lower schools, where the use of the manual and chart may be adopted. Men are not apt to care for that of which they know nothing, however good it may be in itself; but a partial insight into this knowledge will quicken a desire to know more: and there can arise no rational fear that, in the case of the most assiduous student, during the years usually passed at college, the subject of the mathematical sciences will be exhausted.

Geometry is the law of Nature, as it regards action or motion.—And what is geometry? let it be asked ; or the study which we are endeavoring to advocate? To premise, in answer, we remark, that the works of art are imitations, not creations. It may be truly asserted that in mechanics no useful discovery has ever been made, even inadvertently, unless where the mind had been previously drawn out, with or without design, into that natural order of thought, which the association of contiguous objects and a succession of generated motions had suggested to it; and that every

useful invention is nothing more than the development of some natural law, although the inventor himself may not be able to recollect the train of reflections which conducted him to his conclusions. This may serve to show the wisdom of investigating the causes and effects of things in the way which Nature's laws prescribe, in order that advantage may be taken of those irreversible rules of action, and a helpful co-operation instituted between nature and art. In this consists the truth of the maxim that "knowledge is power." The folly of opposing those rules, or dispensing with them, is set forth in the proverbs of every language of which we have any account; and every year, in the conduct of some one or other who spends his time and money in the fruitless search of a motive power inherent in the yet unknown combinations of matter. The laws of motion and forces are here particularly alluded to; and these pervade the universe. Every part of the creation is in motion; air, earth, water, fire, light, heat, sound, time, the planets, comets; and it may be (for the standard of comparison is too great for our comprehension) the whole solar system, all—all are in motion, unvarying, incessant. To these are analogous the mechanical and chemical actions of the works of art; and all are subject to the rules of geometry. The study of geometry is therefore an inquiry into Nature's laws.

A few of the many uses of geometry to a free people enumerated.—Self-government is the great business of the people who would be free: this consists in a voluntary conformity to the best natural and social regulations; which implies a knowledge in the people of their rights and their duties, their wants and their means of providing for them. To a self-governing people every kind of useful knowledge is indispensable, and there is none more prolific of utility than geometry. We have already alluded to the maxim that "knowledge is power;" and besides this, we have it upon the authority of holy writ, that "the soul to be without knowledge is not good." If, therefore, the people of the

United States will preserve their two-fold character of rulers and subjects, and execute the double function in the best manner, the range of their popular education must be extended, and the *pabulum mentis*, the intellectual nutriment, supplied in proportion to the growing wants of their increasing population. To this end every facility should be given to the diffusion of the useful arts, very many of which depend for their origin, progress, and perfection, upon the knowledge of geometry. To enumerate all the uses of this science, would be to evoke the practical operations of the better half of the busy world. Let it suffice to say that it is eminently the science of national defence by land and sea; of strategy or the marshalling of troops; of the motion of projectiles and of gunnery; of the building of ships and fortifications; of navigating the trackless ocean, from the comparison of times and distances, marking the revolutions of the stars and planets. Geometry is the science which teaches the erection and adornment of edifices; the construction of bridges, mills, machines, and engines; the distribution and subduing of the glebe; the graduating and conducting of watercourses and railways; the surveying of coasts, shiproads, and rivers, and marking the relative position of headlands and other stationary objects for the guidance of the mariner in view of land. Geometry furnishes all the principles for the fabrication of musical, optical, and nautical instruments, and the means generally of exerting human power successfully against the resistance of matter in all its forms, so as to accomplish with extreme precision the minutest as well as the most stupendous works.

The study of geometry produces internal order, regulates the morals, and elevates the mind to contemplate the sacred order of the Creator's works.—Geometry is a moral science, or in closer alliance with the science of morals and religion than any other of the physical sciences. The study of it places within the soul, as it were, a framework of truth, on which to dispose in due order the faculties, affections and

passions, under the control of reason; a trellis for the support and display of the fruits of virtuous principles, honorable to the student, and salutary to those who are favored with his worthy example. The diseases incident to a collapsed condition of the moral powers find here a remedy; which powers, so arranged, instead of exhausting their force in mutual collision, severally act their appropriate functions within their destined spheres. The mind is thus led, from its own internal order, to contemplate the sacred order of the Creator's works; to admire the wisdom of their arrangement and the harmony of their several parts; to exult in deriving its own existence immediately from the Almighty Architect himself.

Good government is a Divine unity; and a freeman must either exercise it upon himself, or fall into the hands of another master.—It is not, however, pretended, nor can it be believed, that good morals or good government can exist in the absence of religion. Good government is an indivisible unit, descending from the Blest Supreme, and apportioned to his creatures as they can bear it. It pleases the people of the United States to hold the reins for themselves, by God's grace, not feignedly as usurpers, but as of duty under the most sacred obligations, taking the ultimate responsibility; or to depute the task for a time to chosen men, whose duty it is made to direct the power of the whole equally for the good of each individual: but where self-government is vigorous, external government is the less wanted, and despotism fails of its object through the want of materials upon which to act. But that man is not free who has lost the government of himself—who has broken loose from his own restraint. The apostolic gradation is the theory of perfect liberty,—faith, virtue, knowledge, temperance, patience, godliness, brotherly kindness, charity: these liberating operations are effected by Divine assistance, and not otherwise; for we cannot know even natural things in their true relations, unaided by the internal illustrations of the

wisdom which is from above. Nevertheless, the study of the natural sciences is here recommended in connexion with that of redemption ; but all history attests that the study of the mathematics preponderates vastly in favor of true and exalted piety.

The diagrams and propositions of geometry should be every where exhibited.—If, therefore, these elements of the natural sciences be of so very great importance to the people of the United States, why should any rational means of rendering them effective be neglected in the popular education ? The public and private service of the country calls for a more general diffusion of this knowledge. Either, then, let some better means be devised, or let this chart of the diagrams be spread out, and this manual of the propositions of Euclid be suspended to it, as the farmer suspends his almanac for the service of the year, in every district school ; in every mechanic's shop, every counting-room, every public, society, or firemen's hall, where young men resort ; in the domicil, among the rising youth ; at every military post and naval station ; in the quarters of midshipmen, and petty officers and seamen, when at sea ; and, where it might not be an inappropriate appendage, in the libraries of young lawyers, with the Commentaries of Blackstone and Kent. Then will abler advocates enter the forum, furnished with Euclid's invincible style of argument and the strong fulcrum of truth, on which to rest a plea ; the wet seaboy would devote his watch below to the improvement of his nautical skill ; old soldiers, among whom are not often wanting those who would recognise in Euclid a former acquaintance, would take new delight in explaining to their comrades the nature and application of his diagrams, reminding them of the long defence of Syracuse, by the science of Archimedes, against Marcellus, the sword of Rome ; the apprentice would tax the leisure of his servitude with the acquisition of this knowledge, which would qualify him to test the

strength, under certain combinations, and overcome the resistance or resist the pressure of the massive materials used in the works of art; and the domicil and school would send forth to the halls of legislation orators more succinct and cogent, statesmen better informed respecting the nature of productive labor, the cost of public works, and the economical expenditure of the revenues of the country.

Let the temperance associations, especially, recommend it to the young, as a substitute for the coarse revelry with which they affect to be happy. While reformed men, and those who have always shunned the cup, are uniting their efforts in rooting up the vice of inebriety with all its concomitants, the soil which they clear will not lie fallow; the seeds of many evils exist in the human constitution, ready to spring forth in native luxuriance, in the absence of restraining goodness. The active mind of man seeks employment; and inexperience unfits it for judging of that which is most profitable. If the elements of geometry be disseminated and receive proper culture, the fruit will be perfection in many of the useful arts, and purity and power of self-protection in the details of our institutions. This would produce a salutary action in the body politic, and prevent many of the disorders which disturb the peace of the community.

Geometry is necessary to complete the education of an American citizen.—It was anciently said that there is no royal road to geometry; or, in other words, no way to understand the laws of Nature without the labor of study: this is now a truism, as much as it was in the days of Ptolemy. Here, however, there is no royalty to desire exemption from labor; and freemen labor for themselves; also, in the pursuit of knowledge they seek a treasure beyond the reach of fraud. But, as freemen labor for themselves, so they govern themselves; they therefore require the more skill and knowledge, and those in the greatest variety, from skill in the lowest man-

ual operation to knowledge of the highest exercise of the moral functions of man, that they may perform with decency the subordinate duties of life, and be qualified to govern the state in the true spirit of its constitution and laws. The necessity of greater knowledge is an honorable distinction, but the acquisition of it is more honorable; and the adage *Ne sutor ultra crepidam* is wholly inapplicable to an American citizen. Let this study, therefore, be incorporated with the other useful branches in the general plan of the popular education, in order to complete the basis of a system commensurate with the dignity of this form of government, based as it is upon the inalienable rights of man.

The General and State Governments should patronize the general diffusion of geometry as a military science.—The legislative bodies of the several States, as well as the General Government, should take this subject into their consideration. In the cases of the former, there are, it is believed, no constitutional restrictions; we are not aware that their authority has ever been questioned as regards providing by law for the education of their citizens, regulating the matter and manner of that education, and dispersing the seeds of knowledge freely among the people.

If, however, the jealousy of the States should deny to Congress such a construction of the constitution as would empower that body to legislate on this subject, then we would inquire upon what principle they act when they reserve so many sections of the public lands for the purposes of education? wherefore do they educate one youth from each congressional district at a military school? and by what authority do they devote their time, as a legislative body, in the trusteeship of the Smithsonian bequest? If Congress may appropriate lands, money, and time, for the diffusion of knowledge, who will deny them the power of direction as to the character of that knowledge? Geometry is the basis of the knowledge of the most sublime sciences

known to the human mind, and the best adapted to the condition of a free people ; it is therefore indispensable in the contemplation of any institution which such a people might be expected to establish for the diffusion of general knowledge. Moreover, it is that science which is most congenial with a condition of want and necessity, and most ready to enter as one of the principal means into any plan for the improvement of humanity in its rudest state. But it is also a military science, connected with the defence of the country : if it be expedient, therefore, to diffuse the knowledge of field tactics, it is expedient, *a fortiori*, to diffuse that of geometry, which includes the principles generally that lie at the basis of the art of war. This diffusion, however, cannot be effected, in either part, through the single officer who graduates at West Point : therefore the militia, to whom the country belongs, and who are therefore the proper defenders of it, must remain destitute of this knowledge so necessary to concert of action in the day of trial and peril, or be dependent upon the mercenary skill of others for the defence of their property and lives. Again : if it be the province of Congress to provide by law for organizing companies, battalions, and regiments, and designating their commanders ; also for furnishing arms, equipments, and rations,—is it not likewise the province of that honorable body to provide for the diffusion of such knowledge among them as will give their united action the desired effect ?

To the National Legislature, therefore, we respectfully suggest the propriety of taking into their consideration the diffusion of this elementary knowledge in their several districts, through the medium of the manual and chart of geometry. Let the junior militia participate in the advantages of this military science. Out of many thousands, you educate one : this is well, but not sufficient. And even this scanty provision is uncertain ; for the individual whom you select may be less worthy of command—may be rejected ; and some natural, uninstructed genius, from the plough, may

supersede the cadet upon whom your exclusive patronage has been lavished. *Hinc opera et impensa peribunt.* Educate *one*, and neglect *ten thousand*, and be disappointed !! This is patriotism inverted, tapered to a point, attenuated too finely for the support of the most rarefied aerial existence. *Non illud opus tenuissima stamina vincant.*

General remarks on the utilitarian and tranquilizing character of the study of geometry, and an appeal to those who are placed in a good position to aid in its diffusion.—It is desirable that the plan of the manual and chart should be submitted to trial in the several districts of the United States ; not where the facilities for teaching geometry are already furnished, or in a class which will not advance without the regular demonstrations ; but in a school, or class, which will proceed to collect the facts connected with each proposition, as prescribed in a preceding part of this Essay. This trial cannot, however, be so extensively made, without the kind and efficient co-operation of the members of Congress. We are therefore anxious to enlist their influence and support in behalf of this noble cause. The magnitude of the enterprise fills us with regret that abler talents and more propitious circumstances than those which have fallen to our lot are not engaged in the execution of it. It is not the high refinements of science, the deep research of philosophy, that we would urge on the public attention ; it is the introduction of the principles of geometry into the schools—the diffusion of the seeds of knowledge where they are not. Our object is to lay the foundation of the national education in the proper and sufficient elements ; to simplify the incipient means ; to scatter the good seed *broadcast* in town and country, and send thousands of youths *teeming* with the germs of science to seek the fostering instruction of some adjacent Alma Mater; or, should that be out of their reach, to ascend the hill of science by their own application.

Individual influence, however great, would be too inconsiderable to warrant the expectation of any decided action

in relation to this important work ; its merits will even be rated by the diminutive proportions of those of our agency, which only consist in a zeal for the promotion of the cause of science that has increased with the progressive lapse of thirty-one years. It is now our belief, based on the experience of many vicissitudes, that the perpetuation of the principles laid down in the Declaration of Independence depends on the more equal diffusion of knowledge, the disparity of which has been gradually increasing among the people ; that mathematical science, though perhaps defective in refinement, confers a greater share of power in many important particulars, and is therefore the best among the available means of protection against any encroachment upon social rights ; that the elements of this knowledge should be diffused, even where they must depend solely on the congeniality and vigor of the mental soil for their culture and improvement, trusting that skill and power to combine and employ them would soon appear in the native genius of the young people, whom we cannot thus call up without commanding them to God. We are further of opinion that the studies which we here desire to recommend, if carried out to their legitimate conclusions, could never have connexion with metaphysics, or questions of uncertain data, and consequent "doubtful disputation ;" that they are wholly neutral with respect to points of faith which may be controverted by the various sects in polemical divinity, but unequivocally favorable in their testimony as to the goodness, wisdom, and power of the Creator and Governor of the universe. They are therefore incapable of being employed to promote disorder in communities, of which the inevitable consequences are usurpation and oppression on the part of the rulers, unless where the laws are sufficiently powerful to restore order to the body politic. Moreover, in the lives of distinguished mathematicians which have been handed down to us, we find many able supporters of the doctrines of Christianity ; and there is just reason to believe that many more

have erred, in doctrine and practice, from *want* of the knowledge of geometry, than from its *superabundance*.

The study of the mathematics comes before the *whole people* of the United States, not a thin superstratum, for acceptance or rejection. Where neither the *vis inertiae* of the matter, nor the fugitive volatility of the spirit of man, resists or evades the consideration of the case, the want of power in the agency will be sufficient to exclude the intended advantage. The field is very great, and the laborers must be many. Who, then, will enlist with us in this cause, which has for its object the greatest amount of intellectual and moral good? Will the members of the legislature refuse to convey intelligence on this subject to the friends of popular education in their several districts? May we not expect the concurrence of the distinguished citizens composing the membership of the National Institution in this laudable enterprise? Here is a definite object presented for their action, and one which lies in the entrance of the principal avenue leading to the Temple of the Sciences. The means here proposed require only to be submitted to the impartial test of practical experiment; the people will not forego the obvious advantage of the plan.

TABLE OF CONTENTS.

	Page.
Indications of the desire to diffuse knowledge—	
1. In the action of Congress with regard to the bequest of the late Mr. Smithson	9
2. In the establishment of the National Institution at Washington	11
3. In the action of the friends of popular education in some of the States, resulting from the discoveries made in the last census.....	12
Astronomy, which leads the whole train of the sciences, dependent on the elemenis of geometry.....	13
A magazine of the natural sciences, for the family library, should commence with the elements of arithmetic and geometry.....	15
Geometry and arithmetic should have priority of algebra.....	15
The magazine should explain the terms which involve principles in arithmetic as well as in geometry.....	17
An explanation of the true principle of induction, as applicable to arithmetic.....	18
The leading numbers of the magazine should not contain abstruse questions.....	19
Geometry is at war with the lawless condition of mind and matter.....	20
The investigations of the sciences dependent on geometry are limited within the known parts of the creation; the line and plummet must never be out of use.....	21
The popular education is defective with regard to means	22
An uneducated population are the materials of a despotism.....	22
Domestic education is the most available.....	23
Equal means of education are necessary to preserve a free government, and avarice is its antagonist.....	24
Legislation requires intellectual discipline and experience of the relations of society.....	25
Concentration and diffusion of knowledge contrasted.....	26
The metaphorical tree of knowledge.....	27
School commissioners and trustees are bound to lay a proper foundation for public instruction.....	28
A Chart and Manual of Geometry for the use of schools recommended	29
A description of the Chart and Manual of Geometry, with the title of each, and the supposed terms of their publication.....	30
Geometry and arithmetic should be taught at the same time.....	31

	Page
The entire labor of demonstration should not be at once imposed on the learner; it should be classified.....	31
Youth is the proper time for acquiring the elements of science, and forming an intelligent citizen.....	32
Geometry taken in the Euclidian order is not abstruse, and may be learned by any good reader.....	32
Teachers may acquire this knowledge from the recitations of their pupils, without any previous study.....	33
Colleges have a pecuniary interest in the promotion of this preparatory study.....	34
Geometry is the law of Nature, as it regards action or motion.....	34
A few of the many uses of geometry to a free people enumerated.....	35
The study of geometry produces internal order, regulates the morals, and elevates the mind to contemplate the sacred order of the Creator's works	36
Good government is a Divine unity; and a freeman must either exercise it upon himself, or fall into the hands of another master.....	37
The diagrams and propositions of geometry should be every where exhibited	38
Geometry is necessary to complete the education of an American citizen	39
The General and State Governments should patronize the general diffusion of geometry as a military science.....	40
General remarks on the utilitarian and tranquilizing character of the study of geometry, and an appeal to those who are placed in a good position to aid in its diffusion.....	42

NOTES.—The importance of this subject, included in the general title, may be collected, to some extent, from the several views presented in the pages of this pamphlet.



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